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SOIL-VEGETATION CORRELATIONS IN COASTAL MISSISSIPPI WETLANDS

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PREFACE

The National Ecology Research Center of the U.S. Fish and Wildlife Service (FWS) is supporting a series of field research studies to document relationships between hydric soils and wetland vegetation in selected wetlands throughout the United States. This study is one of that series. It is a continuation of the FWS effort, begun by Wentworth and Johnson (1986), to develop a procedure using vegetation to designate wetlands based on the indicator status of wetland vegetation as described by the FWS "National List of Plants that Occur in Wetlands" (Reed 1986). This list classifies vascular plants of the U.S. into one of five categories according to their natural frequency of occurrence in wetlands. Concurrent with the development of the wetland plant list, the Soil Conservation Service (SCS) developed the "National List of Hydric Soils" (SCS 1985). Studies supported by the National Ecology Research Center quantitatively compare associations of plant species, designated according to their hydric nature using the Wentworth and Johnson (1986) procedure, with the hydric nature of soils according to their designation on the SCS hydric soils list. The studies are being conducted across moisture gradients at a variety of wetland sites throughout the U.S. Several studies have been modified to obtain information on groundwater hydrology.

These studies were conceived in 1984 and implemented in 1985 in response to internal planning efforts of the FWS. They parallel, to some extent, ongoing efforts by the SCS to delineate wetlands for Section 1221 of the Food Security Act of 1985 (the swampbuster provision). The SCS and FWS provided joint guidance and direction in the development of the Wentworth and Johnson (1986) procedure, and the SCS currently is testing a procedure that combines hydric soils and the Wentworth and Johnson procedure for practical wetland delineation. The efforts of both agencies are complimentary and are being conducted in close cooperation.

The primary objectives of these studies are to: (1) assemble a quantitative data base of wetland plant community dominance and codominance for determining the relationship between wetland plants and hydric soils; (2) test various delineation algorithms based on the indicator status of plants against independent measures of hydric character, primarily hydric soils; and (3) test, in some instances, the correlation with groundwater hydrology. The results of these studies also can be used, with little or no supplementary hydrologic information, to compare wetland delineation methods of the Corps of Engineers (1987) and the Environmental Protection Agency (Sipple 1987).

Any questions or suggestions regarding these studies should be directed to: Charles Segelquist, National Ecology Research Center, 2627 Redwing Road, Creekside One, Fort Collins, Colorado, 80526-2899, phone FTS 323-5384 or Commercial (303)266-9384.

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INTRODUCTION

The U.S. Fish and Wildlife Service classification system (Cowardin et al. 1979:3-4) defines wetlands as lands that are:

> ... transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.... Wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.... The upland limit of a wetland is designated as: (1) the boundary between land with predominantly mesophytic and xerophytic cover; (2) the boundary between soil that is predominantly hydric and soil that is predominantly nonhydric; or (3) in the case of wetlands without vegetation or soil, the boundary between land that is flooded or saturated at some time each year and land that is not.

Hydrophytes, or hydrophytic vegetation, are plants that grow in water or a substrate that is periodically deficient in oxygen during the growing season as a result of excessive water content (Soil Conservation Service 1986). Hydric soils are defined as soils that in an undrained condition are saturated, flooded, or inundated long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation (Soil Conservation Service 1985). Correlations between vegetation and soil parameters provide means for delineating and managing wetlands within the United States.

Wetlands in southern Mississippi were selected for a study to examine correlations between hydric soils, as defined by the Soil Conservation Service (1985), and hydrophytic vegetation, identified in the National Wetland Plant List (Reed 1986) of the U.S. Fish and Wildlife Service. The objectives of this study were to: (1) assemble a quantitative data base for determining relationships between the U.S. Fish and Wildlife Service National Wetland Plant List (Reed 1986) and the Soil Conservation Service (1985) Hydric Soils List; (2) estimate the extent to which hydric soils supported a prevalence of hydrophytic vegetation as identified by the indicator status of species recorded in the National Wetland Plant List (Reed 1986); and (3) test Wentworth and Johnson (1986) and other wetland delineation methodologies as they pertain to soil-vegetation correlations.

DESCRIPTION OF STUDY AREA

Our study was performed at the Mississippi Sandhill Crane National Wildlife Refuge, Jackson County, Mississippi (Figure 1). Jackson County is located on the Gulf Coastal Plain, with elevations ranging from sea level to 54 m (Dewhurst 1985).

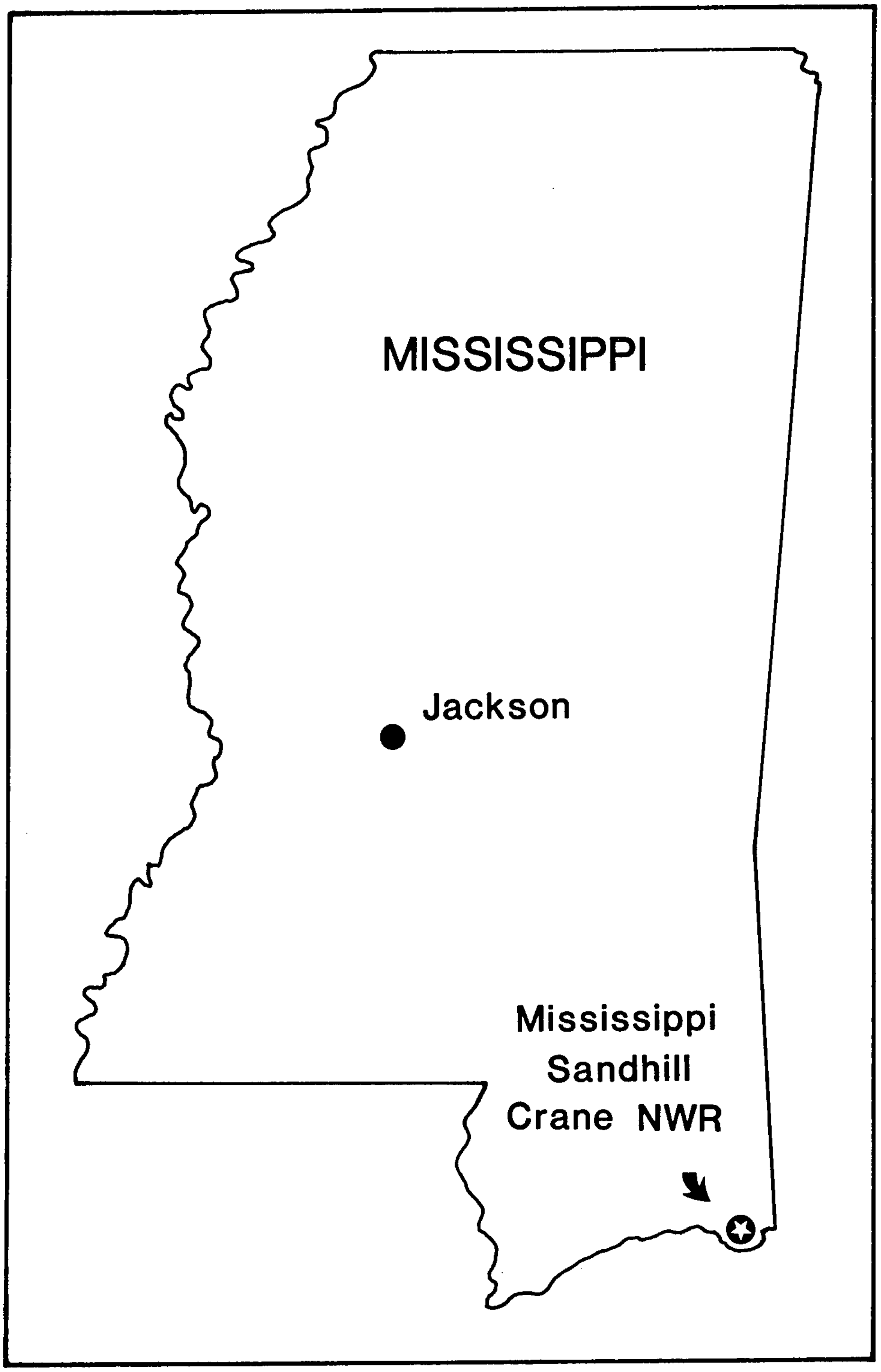

Figure 1. General location of Mississippi Sandhill Crane National Wildlife Refuge.

Timber production is the primary agricultural activity in the county, with field crop production secondary (Cole and Dent 1964). Climate of coastal Mississippi is subtropical and characterized by hot, humid summers. Mean annual precipitation is 184 cm with maximum levels in mid to late summer; mean annual temperature is 20 °C; June through September are hottest, with a mean temperature of 27 °C, and December through February are coldest at 13 °C (Wilson 1987).

The refuge was established in 1975 to provide protection for the endangered Mississippi sandhill crane (*Grus canadensis pulla*), a nonmigratory subspecies, and to preserve unique savanna plant associations (U.S. Fish and Wildlife Service 1987). The refuge contains about 7,290 ha and consists of three separate land tracts (i.e., Gautier, Ocean Springs, and Fontainebleu units) that lie within the nesting range of the Mississippi sandhill cranes. Most soils of the refuge formed under coniferous forest cover, producing strongly acidic, poorly drained loamy soils that are low in organic matter (Dewhurst 1985).

Four main habitat types occur in the refuge: swamps, open savannas (wet prairies), pine (*Pinus* spp.) forests, and tidal marshes. Swamps are composed primarily of woody vegetation, such as blackgum (*Nyssa sylvatica* var. *biflora*), longleaf pine (*Pinus palustris*), slash pine (*Pinus elliottii*), and bald cypress (*Taxodium distichum*), with a sparse understory dominated by sedges (*Rhynchospora* spp. and *Carex* spp.). Mississippi sandhill cranes rely heavily on savanna habitats for nesting and foraging. Clearing and burning of encroaching woody vegetation are used to maintain herbaceous associations of the savannas; the refuge fire management program prescribes burning about 30% of refuge acreage annually (U.S. Fish and Wildlife Service 1986). Typical species of the savannas include little bluestem (*Schizachyrium scoparium*), toothache grass (*Ctenium aromaticum*), pipeworts (*Eriocaulon compressum* and *E. decangulare*), sedges (*Rhynchospora* spp. and *Scleria* spp.), pitcher plants (*Sarracenia alata* and *S. psittacina*), sundew (*Drosera capillaris*), and composites (*Balduina uniflora*, *Carphephorus pseudoliatris*, and *Helianthus heterophyllus*). Understory associated with pine forests includes wiregrass (*Aristida stricta*) and little bluestem (*Schizachyrium scoparium*).

METHODS

Field work was conducted from mid-September to mid-October 1987 (i.e., during the dry season). Four hydric soil series (i.e., Atmore, Hyde, and Plummer in savannas, and Croatan in swamps) and one nonhydric soil (i.e., Harleston in upland pine forests) were sampled at the refuge to determine whether they supported predominantly hydrophytic vegetation; descriptions of these soils are given in Appendix A. Three hydric soils (Daleville, Hansboro, and Leaf series) were not sampled because they were not well represented at the refuge. Hydric soils initially were identified from the Hydric Soils List of Mississippi (Soil Conservation Service 1985) and the Jackson County Soil Survey (Cole and Dent 1964). All indentifications were confirmed with Tom Kilpatrick, soil scientist, Jackson County Soil Conservation Service.

Four study sites were chosen within each soil series; in general, disturbed sites were not sampled. Five study plots of 100 m^2 were established randomly at each study site. Vegetation within plots was sampled by strata: trees, large shrubs, small shrubs, and ground cover (Table 1); quadrats for strata were nested within each 100-

Table 1. Sampling schemes for vegetation strata.

Vegetation strata	Variables measured	Size of quadrats (m^2)	Quadrats per soil series
Ground cover: woody species <0.5 m and all herbaceous species regardless of height	Percent cover	0.5	40
Small shrubs: woody species <1.3 m, >0.5 m	Density - count all plants emerging from ground	4	20
Large shrubs: woody species <7.5 cm dbh, >1.3 m high	Density - count all main leaders	4	20
Trees: all stems >7.5 cm dbh	Density - basal area (from dbh estimates)	100	20

m^2 plot. Plant species were identified in the field whenever possible; unknown species were collected, pressed, and identified later in the laboratory. Botanists Cary Norquist (Office of Endangered Species, U.S. Fish and Wildlife Service, Jackson, MS) and Dr. Sidney McDaniel (Mississippi State University, Starksville, MS) provided assistance with plant identification.

Plant species were assigned numerical values that corresponded to ecological indices from the National Wetland Plant List (Reed 1986), based on frequencies of occurrence in wetlands (Table 2). Individuals that could not be identified to species because of advanced phenology were assigned the most conservative ecological index for the genus and were analyzed together. Unidentified species were not used in our analyses.

Weighted averages for individual and combined vegetation strata were calculated for each soil series. The equation used was taken from Wentworth and Johnson (1986):

$$W_j = \left(\sum_{i=1}^{n} I_{ij} E_i \right) / \left(\sum_{i=1}^{n} I_{ij} \right)$$

where: W_j = weighted average for stand j; I_{ij} = importance value for species i in stand j; E_i = ecological index for species i; and n = number of species in stand j. Im-

Table 2. Ecological indices used for weighted, presence/absence, and rescaled Michener averages, with definitions of modifiers in the National Wetland Plant Species List (Reed 1986).

Ecological indices	Index values (E_i)[a]			Definition
	W	P	M	
Obligate	1	1	1.00	Species always occurs in wetlands (frequency >99%)
Facultative Wet	2	2	1.67	Species usually occurs in wetlands (67%-99% frequency)
Facultative	3	3	3.00	Species sometimes occurs in wetlands (34%-66% frequency)
Facultative Upland	4	4	4.33	Species seldom occurs in wetlands (1%-33% frequency)
Upland	5	5	5.00	Species occurs in wetlands with less than 1% frequency; also includes species not assigned one of the above modifiers

[a]Numerical values assigned to ecological indices as specified by weighted (W) (Wentworth and Johnson 1986), presence/absence average (P), and Michener (1983) average (M) equations.

portance values correspond to "variables measured" listed in Table 1, and ecological indices assigned to species are listed in Table 2.

Modified Wentworth and Johnson (1986) equations were used to calculate presence/absence averages (P_j), referred to as index averaging by Wentworth and Johnson (1986), and Michener (1983) averages (M_j) for vegetation strata within soil series. Presence/absence averages used the same ecological index values (E_i) as did weighted averages (Table 2); however, the importance value (I_{ij}) was equal to 1 when a species was present in a quadrat or 0 when absent. Michener averages used the same importance values as weights, but they had ecological index values that skewed facultative wetland and upland values toward obligate wetland and upland values, respectively (Table 2).

Frequencies based on density measurements were calculated for taxa by vegetation strata within each soil series. Means, standard errors of means, and ranges also were calculated for weighted, presence/absence, and Michener averages by vegetation strata within each soil series. Averages generated by the three methods were analyzed using Analysis of Variance and Duncan's multiple range

tests. Soil series having weighted, presence/absence averages, and Michener averages less than 3.0 were designated as supporting predominantly hydrophytic vegetation, an indicator of wetland conditions.

RESULTS

Of the 151 taxa identified in our study (Appendix B), 144 occurred in the ground cover stratum, 16 in the shrub stratum, and 11 in the tree stratum (Appendix C). Frequencies of occurrence of taxa encountered in soil series within each vegetation strata are given in Appendix C.

Means, standard errors of means, and ranges were calculated for weighted averages, presence/absence averages, and Michener averages for soil series and sampling sites within vegetation strata (Tables 3, 4, and 5). Mean values for soil series within vegetation strata also were analyzed using Duncan's multiple range tests (Tables 6, 7, and 8); values assigned the same letters were not statistically different. Soil series that are designated as supporting predominantly hydrophytic vegetation are those with calculated mean values less than 3.0; soils considered hydric by the Soil Conservation Service (1985) are indicated with asterisks (*).

Correlations between hydric soils and a prevalence of hydrophytic vegetation were not consistent. Mean values of hydric soils within each vegetation strata were less than 3.0 with one exception; mean values for the Plummer series in the tree stratum were greater than 3.0 (using all averaging methods), even though the series is included in the Hydric Soils List. No significant differences existed between the nonhydric Harleston soil and those series designated as hydric by the Soil Conservation Service (Atmore, Croatan, Hyde, and Plummer). No separation of hydric and nonhydric soils occurred in the tree and shrub strata, and although the Harleston series was statistically different from the hydric series in the ground cover stratum, the mean value for the series was less than 3.0, which indicated a prevalence of hydrophytic vegetation.

DISCUSSION

Good correlations were observed between the hydric soils identified in the Hydric Soils List (Soil Conservation Service 1985) and a predominance of hydrophytic vegetation identified in the National Wetland Plant List (Reed 1986). In general, weighted, presence/absence, and Michener averages indicated that the hydric soils (Atmore, Croatan, Hyde, and Plummer) supported primarily hydrophytic vegetation. However, none of the three methods clearly distinguished the hydric soils from nonhydric Harleston soil based on vegetation composition.

Several hypotheses can be offered as to why hydric and nonhydric soil series were not statistically separable using our vegetation data. First, the Wentworth and Johnson (1986) methodologies may not be adequate for discriminating between all hydric and nonhydric soils; however, these methods originally were tested with a broad data base from North Carolina, Nebraska, Montana, Washington, and Texas wetland systems. Recent investigations in California (Baad 1988; Eicher 1988), Nebraska (Erickson and Leslie 1987), Nevada (Nachlinger 1988), New Mexico (Dick-Peddie et al. 1987), North Carolina (Christensen et al. 1988), and South

Table 3. Means, standard errors of means, and ranges for weighted averages for soil series and sampling sites within vegetation strata.

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
		GROUND COVER STRATUM		
*Atmore	40	1.641	0.022	0.596
1	10	1.553	0.058	0.596
2	10	1.691	0.048	0.450
3	10	1.648	0.029	0.311
4	10	1.670	0.024	0.233
*Croatan	40	1.460	0.065	1.429
1	10	1.986	0.120	1.254
2	10	1.208	0.060	0.435
3	10	1.359	0.071	0.668
4	10	1.285	0.091	0.929
*Hyde	40	1.972	0.046	1.127
1	10	1.956	0.072	0.640
2	10	2.304	0.088	0.820
3	10	1.785	0.046	0.467
4	10	1.841	0.057	0.608
*Plummer	40	1.820	0.041	1.139
1	10	1.550	0.032	0.307
2	10	1.866	0.069	0.648
3	10	1.860	0.057	0.580
4	10	2.002	0.092	0.862
Harleston	40	2.396	0.102	2.725
1	10	3.125	0.196	1.811
2	10	2.650	0.088	0.939
3	10	1.841	0.076	0.780
4	10	1.970	0.078	0.886

(Continued)

Table 3. (Continued)

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
		SMALL SHRUB STRATUM		
*Atmore	03	2.000	0.000	0.000
2	01	2.000	--[c]	0.000
3	01	2.000	--	0.000
4	01	2.000	--	0.000
*Croatan	08	2.150	0.080	0.500
1	04	2.300	0.122	0.500
2	01	2.000	--	0.000
4	03	2.000	0.000	0.000
*Hyde	15	2.041	0.029	0.375
1	05	2.000	0.000	0.000
2	05	2.000	0.000	0.000
4	05	2.123	0.078	0.375
*Plummer	15	2.067	0.067	1.000
1	01	3.000	--	0.000
2	04	2.000	0.000	0.000
3	05	2.000	0.000	0.000
4	05	2.000	0.000	0.000
Harleston	15	2.002	0.002	0.032
1	01	2.000	--	0.000
2	04	2.000	0.000	0.000
3	05	2.000	0.000	0.000
4	05	2.006	0.006	0.032
		LARGE SHRUB STRATUM		
*Croatan	01	2.000	--	0.000
1	01	2.000	--	0.000

(Continued)

Table 3. (Continued)

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
*Plummer	01	2.000	--	0.000
4	01	2.000	--	0.000
Harleston	02	2.000	0.000	0.000
2	02	2.000	0.000	0.000
		TREE STRATUM		
*Croatan	20	1.757	0.108	1.449
1	05	2.225	0.110	0.519
2	05	1.672	0.181	0.955
3	05	1.212	0.076	0.390
4	05	1.917	0.187	1.070
*Hyde	05	2.200	0.200	1.000
1	02	2.500	0.500	1.000
2	03	2.000	0.000	0.000
*Plummer	11	3.091	0.315	2.000
2	05	2.000	0.000	0.000
3	04	4.000	0.000	0.000
4	02	4.000	0.000	0.000
Harleston	11	2.036	0.030	0.327
2	05	2.000	0.000	0.000
3	01	2.000	--	0.000
4	05	2.079	0.063	0.327
		COMBINED STRATA		
*Atmore	20	1.671	0.032	0.609
1	05	1.570	0.060	0.332
2	05	1.711	0.090	0.510

(Continued)

Table 3. (Concluded)

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
3	05	1.693	0.053	0.307
4	05	1.711	0.038	0.210
*Croatan	20	1.638	0.082	1.138
1	05	2.119	0.033	0.161
2	05	1.502	0.100	0.576
3	05	1.289	0.087	0.511
4	05	1.643	0.121	0.736
*Hyde	20	1.972	0.037	0.649
1	05	2.040	0.057	0.312
2	05	2.103	0.036	0.222
3	05	1.751	0.056	0.282
4	05	1.994	0.034	0.172
*Plummer	20	2.097	0.092	1.243
1	05	1.723	0.156	0.829
2	05	1.924	0.038	0.202
3	05	2.487	0.119	0.618
4	05	2.254	0.186	0.897
Harleston	20	2.282	0.118	1.924
1	05	2.995	0.290	1.425
2	05	2.189	0.027	1.161
3	05	1.918	0.050	0.260
4	05	2.027	0.016	0.095

[a]Asterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conservation Service 1985).
[b]Difference between maximum and minimum observations.
[c]Indicates that the standard error of means was not calculated due to inadequate sample size.

Table 4. Means, standard errors of means, and ranges for presence/absence averages by soil series and sampling sites within vegetation strata.

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
		GROUND COVER STRATUM		
*Atmore	40	1.701	0.022	0.545
1	10	1.585	0.037	0.422
2	10	1.653	0.042	0.440
3	10	1.828	0.035	0.303
4	10	1.736	0.023	0.186
*Croatan	40	1.586	0.064	1.667
1	10	1.988	0.121	1.333
2	10	1.487	0.134	1.000
3	10	1.507	0.065	0.583
4	10	1.362	0.092	1.000
*Hyde	40	1.975	0.027	0.697
1	10	2.007	0.062	0.697
2	10	2.162	0.039	0.366
3	10	1.886	0.022	0.208
4	10	1.845	0.023	0.280
*Plummer	40	1.812	0.022	0.669
1	10	1.774	0.028	0.296
2	10	1.815	0.063	0.545
3	10	1.830	0.025	0.255
4	10	1.829	0.057	0.583
Harleston	40	2.151	0.053	1.429
1	10	2.517	0.109	0.882
2	10	2.042	0.056	0.500
3	10	1.946	0.077	0.867
4	10	2.099	0.080	0.829

(Continued)

Table 4. (Continued)

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
		SMALL SHRUB STRATUM		
*Atmore	03	2.000	0.000	0.000
2	01	2.000	--[c]	0.000
3	01	2.000	--	0.000
4	01	2.000	--	0.000
*Croatan	08	2.167	0.083	0.500
1	04	2.333	0.118	0.500
2	01	2.000	--	0.000
4	03	2.000	0.000	0.000
*Hyde	15	2.050	0.036	0.500
1	05	2.000	0.000	0.000
2	05	2.000	0.000	0.000
4	05	2.150	0.100	0.500
*Plummer	15	2.067	0.067	1.000
1	01	3.000	--	0.000
2	04	2.000	0.000	0.000
3	05	2.000	0.000	0.000
4	05	2.000	0.000	0.000
Harleston	15	2.011	0.011	0.167
1	01	2.000	--	0.000
2	04	2.000	0.000	0.000
3	05	2.000	0.000	0.000
4	05	2.033	0.033	0.167
		LARGE SHRUB STRATUM		
*Croatan	01	2.000	--	0.000
1	01	2.000	--	0.000

(Continued)

Table 4. (Continued)

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
*Plummer	01	2.000	--	0.000
4	01	2.000	--	0.000
Harleston	02	2.000	0.000	0.000
2	02	2.000	0.000	0.000
		TREE STRATUM		
*Croatan	20	2.199	0.070	1.167
1	05	2.330	0.088	0.467
2	05	2.433	0.125	0.667
3	05	2.033	0.186	1.167
4	05	2.000	0.000	0.000
*Hyde	05	2.200	0.200	1.000
1	02	2.500	0.500	1.000
2	03	2.000	0.000	0.000
*Plummer	11	3.091	0.315	2.000
2	05	2.000	0.000	0.000
3	04	4.000	0.000	0.000
4	02	4.000	0.000	0.000
Harleston	11	2.091	0.061	0.500
2	05	2.000	0.000	0.000
3	01	2.000	--	0.000
4	05	2.200	0.122	0.500
		COMBINED STRATA		
*Atmore	20	1.725	0.029	0.407
1	05	1.609	0.051	0.284
2	05	1.687	0.074	0.396

(Continued)

Table 4. (Concluded)

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
3	05	1.834	0.020	0.101
4	05	1.773	0.025	0.144
*Croatan	20	1.913	0.060	0.861
1	05	2.196	0.041	0.237
2	05	1.955	0.144	0.708
3	05	1.752	0.106	0.583
4	05	1.749	0.041	0.190
*Hyde	20	1.993	0.026	0.498
1	05	2.060	0.060	0.328
2	05	2.044	0.025	0.150
3	05	1.861	0.025	0.160
4	05	2.005	0.042	0.220
*Plummer	20	2.121	0.080	0.990
1	05	1.926	0.128	0.740
2	05	1.913	0.039	0.213
3	05	2.460	0.135	0.696
4	05	2.187	0.189	0.821
Harleston	20	2.140	0.056	0.931
1	05	2.452	0.126	0.685
2	05	2.012	0.015	0.091
3	05	1.963	0.052	0.274
4	05	2.131	0.063	0.367

[a]Asterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conservation Service 1985).
[b]Difference between maximum and minimum observations.
[c]Indicates that the standard error of means was not calculated due to inadequate sample size.

Table 5. Means, standard errors of means, and ranges for rescaled Michener averages by soil series and sampling sites within vegetation strata.

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
		GROUND COVER STRATUM		
*Atmore	40	1.561	0.022	0.604
1	10	1.498	0.062	0.604
2	10	1.600	0.050	0.484
3	10	1.579	0.034	0.398
4	10	1.567	0.024	0.224
*Croatan	40	1.369	0.054	1.240
1	10	1.768	0.117	1.123
2	10	1.184	0.057	0.420
3	10	1.329	0.068	0.664
4	10	1.195	0.065	0.669
*Hyde	40	1.875	0.045	1.161
1	10	1.806	0.065	0.611
2	10	2.201	0.091	0.827
3	10	1.720	0.051	0.535
4	10	1.772	0.061	0.643
*Plummer	40	1.715	0.044	1.225
1	10	1.454	0.029	0.263
2	10	1.725	0.068	0.673
3	10	1.757	0.060	0.583
4	10	1.924	0.108	1.074
Harleston	40	2.271	0.114	2.698
1	10	3.118	0.195	1.803
2	10	2.601	0.095	1.027
3	10	1.641	0.074	0.826
4	10	1.724	0.056	0.650

(Continued)

Table 5. (Continued)

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
		SMALL SHRUB STRATUM		
*Atmore	03	1.670	0.000	0.000
2	01	1.670	--[c]	0.000
3	01	1.670	--	0.000
4	01	1.670	--	0.000
*Croatan	08	1.870	0.107	0.665
1	04	2.069	0.163	0.665
2	01	1.670	--	0.000
4	03	1.670	0.000	0.000
*Hyde	15	1.724	0.038	0.499
1	05	1.670	0.000	0.000
2	05	1.670	0.000	0.000
4	05	1.833	0.104	0.499
*Plummer	15	1.759	0.089	1.330
1	01	3.000	--	0.000
2	04	1.670	0.000	0.000
3	05	1.670	0.000	0.000
4	05	1.670	0.000	0.000
Harleston	15	1.673	0.003	0.043
1	01	1.670	--	0.000
2	04	1.670	0.000	0.000
3	05	1.670	0.000	0.000
4	05	1.679	0.009	0.043
		LARGE SHRUB STRATUM		
*Croatan	01	1.670	--	0.000
1	01	1.670	--	0.000

(Continued)

Table 5. (Continued)

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
*Plummer	01	1.670	--	0.000
4	01	1.670	--	0.000
Harleston	02	1.670	0.000	0.000
2	02	1.670	0.000	0.000
		TREE STRATUM		
*Croatan	20	1.701	0.101	1.436
1	05	2.027	0.159	0.780
2	05	1.680	0.185	0.977
3	05	1.210	0.078	0.400
4	05	1.887	0.181	1.066
*Hyde	05	1.936	0.266	1.330
1	02	2.335	0.665	1.330
2	03	1.670	0.000	0.000
*Plummer	11	3.121	0.419	2.660
2	05	1.670	0.000	0.000
3	04	4.330	0.000	0.000
4	02	4.330	0.000	0.000
Harleston	11	1.718	0.040	0.435
2	05	1.670	0.000	0.000
3	01	1.670	--	0.000
4	05	1.775	0.084	0.435
		COMBINED STRATA		
*Atmore	20	1.571	0.029	0.593
1	05	1.513	0.071	0.360
2	05	1.599	0.091	0.533

(Continued)

Table 5. (Concluded)

Soil series[a]/ sampling site	N	Mean	Standard error of means	Range[b]
3	05	1.592	0.038	0.217
4	05	1.580	0.015	0.085
*Croatan	20	1.548	0.066	0.977
1	05	1.912	0.050	0.288
2	05	1.474	0.101	0.589
3	05	1.272	0.087	0.509
4	05	1.535	0.097	0.592
*Hyde	20	1.791	0.031	0.595
1	05	1.818	0.076	0.403
2	05	1.860	0.033	0.191
3	05	1.678	0.063	0.340
4	05	1.808	0.049	0.254
*Plummer	20	1.957	0.106	1.307
1	05	1.634	0.163	0.866
2	05	1.666	0.031	0.166
3	05	2.417	0.154	0.799
4	05	2.109	0.237	1.116
Harleston	20	2.069	0.140	2.135
1	05	2.947	0.318	1.581
2	05	1.946	0.032	0.193
3	05	1.654	0.047	0.266
4	05	1.730	0.035	0.188

[a]Asterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conservation Service 1985).
[b]Difference between maximum and minimum observations.
[c]Indicates that the standard error of means was not calculated due to inadequate sample size.

Table 6. Duncan multiple range tests for weighted averages calculated for soil series within vegetation strata.

Duncan grouping[a]	Soil series[b]	Mean	N
	GROUND COVER STRATUM		
A	Harleston	2.396	40
B	*Hyde	1.972	40
B	*Plummer	1.820	40
C	*Atmore	1.641	40
D	*Croatan	1.460	40
	SMALL SHRUB STRATUM		
A	*Croatan	2.150	08
A	*Plummer	2.067	15
A	*Hyde	2.041	15
A	Harleston	2.002	15
A	*Atmore	2.000	03
	LARGE SHRUB STRATUM		
A	*Croatan	2.000	01
A	*Plummer	2.000	01
A	Harleston	2.000	02
	TREE STRATUM		
A	*Plummer	3.091	11
B	*Hyde	2.200	05
B	Harleston	2.036	11
B	*Croatan	1.757	20
	COMBINED STRATA		
A	Harleston	2.282	20
A	*Plummer	2.097	20
A	*Hyde	1.972	20
B	*Atmore	1.671	20
B	*Croatan	1.638	20

[a]Mean values for soil series within the same letter grouping are not statistically different.
[b]Asterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conserv. Serv. 1985).

Table 7. Duncan multiple range tests for presence/absence averages calculated for soil series by vegetation strata.

Duncan grouping[a]	Soil series[b]	Mean	N
	GROUND COVER STRATUM		
A	Harleston	2.151	40
B	*Hyde	1.975	40
C	*Plummer	1.812	40
C,D	*Atmore	1.701	40
D	*Croatan	1.586	40
	SMALL SHRUB STRATUM		
A	*Croatan	2.167	08
A	*Plummer	2.067	15
A	*Hyde	2.050	15
A	Harleston	2.011	15
A	*Atmore	2.000	03
	LARGE SHRUB STRATUM		
A	*Croatan	2.000	01
A	*Plummer	2.000	01
A	Harleston	2.000	02
	TREE STRATUM		
A	*Plummer	3.091	11
B	*Hyde	2.200	05
B	*Croatan	2.199	20
B	Harleston	2.091	11
	COMBINED STRATA		
A	Harleston	2.140	20
A	*Plummer	2.121	20
A	*Hyde	1.993	20
A	*Croatan	1.913	20
B	*Atmore	1.725	20

[a]Mean values for soil series with the same letter grouping are not statistically different.
[b]Asterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conserv. Serv. 1985).

Table 8. Duncan multiple range tests for rescaled Michener averages calculated for soil series by vegetation strata.

Duncan grouping[a]	Soil series[b]	Mean	N
	GROUND COVER STRATUM		
A	Harleston	2.271	40
B	*Hyde	1.875	40
B,C	*Plummer	1.715	40
C	*Atmore	1.561	40
D	*Croatan	1.369	40
	SMALL SHRUB STRATUM		
A	*Croatan	1.869	08
A	*Plummer	1.759	15
A	*Hyde	1.724	15
A	Harleston	1.673	15
A	*Atmore	1.670	03
	LARGE SHRUB STRATUM		
A	Harleston	1.670	02
A	*Plummer	1.670	01
A	*Croatan	1.670	01
	TREE STRATUM		
A	*Plummer	3.121	11
B	*Hyde	1.936	05
B	Harleston	1.718	11
B	*Croatan	1.701	20
	COMBINED STRATA		
A	Harleston	2.069	20
A	*Plummer	1.957	20
A	*Hyde	1.791	20
B	*Atmore	1.571	20
B	*Croatan	1.548	20

[a]Mean values for soil series with the same letter grouping are not statistically different.
[b]Asterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conserv. Serv. 1985).

Dakota (Hubbard et al. 1988) generally support the concept that weighted average values can discriminate between hydric and nonhydric soils. Thus, it is unlikely that Wentworth and Johnson (1986) methods would not be appropriate for Mississippi coastal wetlands.

Second, low numbers of species and/or sampling sites in the shrub and tree strata may have been insufficient for statistical analyses and thus were inadequate for separating soil series based on vegetation in some strata. For example, the Plummer series, which is a Soil Conservation Service hydric soil, had mean values for the tree stratum that were greater than 3.0 (indicating that the series did not support predominantly wetland vegetation). However, those calculations were based on data from only two species (*Pinus palustris*, classified as a facultative upland species, and *P. elliottii*, classified as a facultative wetland species). Sufficient numbers of species and samples were obtained in the ground cover vegetation, and subsequent analyses of this stratum separated the nonhydric Harleston soil from the hydric series. Although all three methods (weighted, presence/absence, and Michener averages) indicated that the Harleston series differed from the other soils in its composition of ground cover vegetation, a predominance of upland flora (indicating nonhydric conditions) was not observed.

Third, it is possible that the Harleston soil is misclassified as nonhydric. Minimal elevational changes between the Harleston soil and wetland sites and/or a high water table in these coastal habitats may permit hydrophytic species to grow on soil series that have been considered nonhydric by the Soil Conervation Service. A maritime climate could maintain moist conditions, at least seasonally, in upland areas, allowing hydrophytic plants to colonize such habitats. Further research is necessary to test this hypothesis.

Correspondence among averaging methods indicated that both the nonhydric Harleston series and the hydric soils supported hydrophytic vegetation and are more similar in their hydric affinities than previously believed. The Soil Conservation Service describes the Harleston series as formed in marine or stream deposits, which may indicate hydric influences (see Appendix A). Inclusion of the Harleston series in the Hydric Soils List (Soil Conservation Service 1985) appears to warrant further consideration.

CONCLUSIONS

Weighted, presence/absence, and Michener averages were calculated for soil series within vegetational strata in the Mississippi Sandhill Crane National Wildlife Refuge, and then compared using Duncan's multiple range test. Mean values less than 3.0 indicated that the soil series supported primarily hydrophytic vegetation.

Good correlations were seen between Soil Conservation Service (1985) hydric soils and hydrophytic vegetation identified in the National Wetland Plant List (Reed 1986). Most values generated for hydric soils series (Atmore, Croatan, Hyde, and Plummer) were less than 3.0; one exception was the Plummer soil series in the tree stratum.

The nonhydric Harleston series was not statistically separable from the hydric soils in tree, shrub, and combined strata; only ground cover vegetation data provided

some means for differentiating hydric and nonhydric soils, although averages were below 3.0. Possible explanations why our data did not adequately separate hydric from nonhydric soils include: (1) the vegetation on the nonhydric Harleston series was influenced by a high water table, resulting in a preponderance of hydrophytic vegetation; and (2) the Harleston series should be included on the Hydric Soils List (Soil Conservation Service 1985). Further research will be required to determine the status of the Harleston series.

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APPENDIX A

DESCRIPTIONS OF SOIL SERIES

ATMORE: formerly Rains series; consists of deep, poorly drained, moderately slowly permeable soils formed in loamy marine sediments; located at depressions and interstream divides; with 0-5% slope; typical pedon: Ap--0-18 cm, dark gray silt loam with few fine gray mottles, friable, strongly acid; Eg--18-33 cm, gray silt loam, few distinct strong brown mottles, friable, strongly acid; Bg/Eg--33-76 cm, light gray silt loam, many coarse distinct yellow and common medium distinct yellowish brown mottles, slightly sticky, strongly acid; Btvg1--76-122 cm, light gray silt loam, common coarse distinct yellow, yellowish red, and yellowish brown mottles, slightly sticky in the saturated gray areas, strongly acid; Btvgt2--122-178 cm, mottled light gray, dark red, and yellow silty clay loam, sticky in saturated gray areas, firm, brittle, and compact in dark red area and in some of the yellow areas, strongly acid; most of the soil is used for woodland or pasture; forested areas are of slash, loblolly, and longleaf pine with an understory of gallberry, saw palmetto, wiregrass, and pitcher plant; distribution of Coastal Plain throughout Alabama, Florida, Mississippi, and possibly Louisiana and Texas.

CROATAN: formerly Swamp series; consists of very poorly drained, organic soils that formed in highly decomposed organic material underlain by loamy textured marine and fluvial sediment; with 0-2% slope; typical pedon: Oa1--0-23 cm, black broken face and rubbed sapric material, very friable, about 95% organic content, extremely acid; Oa2--23-38 cm, black broken face and rubbed sapric material, very friable, about 90% organic content, extremely acid; Oa3--38-71 cm, black broken face rubbed sapric material, very friable, about 75% organic content, extremely acid; 2Ag--71-84 cm, black mucky sandy loam, very friable, about 80% mineral content, extremely acid; 2Cg1--84-97 cm, dark brown sandy loam, very friable, extremely acid; 2Cg2--97-152 cm, grayish brown sandy clay loam, slightly sticky, slightly plastic, extremely acid; 2Cg3--152-203 cm, mottled grayish brown and dark gray loamy sand, very friable, extremely acid; most of the soil is wooded, with native vegetation consisting of titi, gallberry, greenbriar, sphagnum moss, redbay, sweetbay, swamp tupelo, and bald cypress; distribution from Middle and Lower Coastal Plain of Alabama, North Carolina, South Carolina, Virginia, and possibly Florida and Mississippi.

HARLESTON: formerly Goldsboro and Lynchburg series; consists of deep, moderately well drained, moderately permeable soils that formed in marine or stream deposits consisting of thick beds of sandy loam; with 0-12% slope; typical pedon: Ap--0-13 cm, very dark gray loam, very friable, very strongly acid; E--13-23 cm, light olive brown loam, very friable, very strongly acid; Bt1--23-51 cm, yellowish brown loam, friable, patchy clay films, very strongly acid; Bt2--51-66 cm, yellowish brown loam, many medium and coarse distinct yellowish red and common medium distinct light brownish gray mottles, patchy clay film, very strongly acid; Bt3--66-84 cm, brownish yellow loam, common medium distinct light brownish gray, pale brown, and strong brown mottles, friable, few pockets of sandy loam, very strongly acid; Bt4--84-152 cm, yellowish brown loam, many medium and coarse distinct brown and light brownish gray mottles, friable, slightly brittle, patchy clay films, very strongly acid; Bt5--152-183 cm, coarsely mottled red, gray, yellowish brown, and strong brown sandy clay loam, friable, slightly brittle, patchy clay films, very strongly acid; most soil is in pine forest, with understory of gallberry, wax myrtle, and native grasses; distribution of the Southern Coastal Plain in Mississippi, Alabama, and Arkansas.

HYDE: formerly Bayboro series; very poorly drained soil, with moderately slow permeability, that formed in marine and fluvial deposits of silts, sands, and clays; located in nearly level areas and slight depressions; with 0-2% slope; typical pedon: Ap--0-25 cm, black loam, very friable, high organic content, very strongly acid; A12--25-38 cm, very dark gray loam, friable, medium organic content, very strongly acid; B2tg--38-89 cm, dark gray clay loam, few medium distinct strong brown mottles, friable, slightly sticky and plastic, very strongly acid; B3g--89-114 cm, dark gray clay loam, few medium distinct strong brown mottles, firm, slightly sticky and plastic,

very strongly acid; C1g--114-140 cm, gray clay loam, few distinct yellowish brown mottles, firm, very strongly acid; C2g--140-165 cm, gray clay loam, common medium yellowish brown mottles, firm, some pockets of fine sandy loam and clay, strongly acid; largely in forested areas of water-tolerant oaks, sweetgum, blackgum, bald cypress, pines, wax myrtle, and maples; distribution of Coastal Plains of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Virginia, and possibly Maryland.

PLUMMER: consists of deep, poorly drained, moderately permeable soils that formed in sandy and loamy sediments of marine terraces; located at level or depressional landscapes and along poorly defined drains; with 0-1% slope; typical pedon: A1--0-23 cm, dark gray sand, very friable, very strongly acid; A21g--23-71 cm, light gray sand, loose, very strongly acid; A22g--71-127 cm, light gray sand, loose, very strongly acid; B2tg--127-183 cm, light gray sandy loam with bodies of sandy clay loam, common medium and fine distinct yellowish brown mottles, friable, very strongly acid; mostly mixed forests of pines, swamp tupelo, and bald cypress, with understory of gallberry, wax myrtle, pitcher plants, wiregrass, and brackenferns; distribution of Atlantic and Gulf Coast Flatwoods, and to a limited extent Southern Coastal Plain, in Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, and Virginia.

APPENDIX B

ALPHABETICAL LISTING OF SCIENTIFIC NAMES, CODES, AND NATIONAL WETLAND INVENTORY ECOLOGICAL INDICES OF PLANT SPECIES IDENTIFIED AT THE MISSISSIPPI SANDHILL CRANE NATIONAL WILDLIFE REFUGE

SCIENTIFIC NAME[a]	CODE[b]	INDEX[c]
Acer rubrum	ACRU	FAC
Agalinis aphylla	AGAP3	FACW
Agalinis obtusifolia	AGOB	FAC*[d]
Aletris lutea	ALLU	FACW
Andropogon mohrii	ANMO3	OBL
Antennaria sp.	ANTEN	FACU
Anthaenantia rufa	ANRU	FACU
Aristida affinis	ARAF	OBL
Aristida stricta	ARST5	FAC
Arundinaria gigantea	ARGI	FACW
Asclepias sp.	ASCLE	FACW
Asclepias longifolia	ASLO	FACW
Ascyrum stans	ASST2	FACW
Aster dumosus	ASDU	FAC
Axonopus affinis	AXAF	FACW
Balduina uniflora	BAUN	FACW
Bartonia virginica	BAVI3	FACW
Bigelowia nudata	BINU	FACW
Bignonia capreolata	BICA	FAC*
Burmannia capitata	BUCA3	OBL*
Carex glaucescens	CAGL5	OBL
Carphephorus pseudo-liatris	CAPS5	OBL*
Cassia nictitans	CANI4	FACU
Centella asiatica	CEAS	FACW
Chaptalia tomentosa	CHTO	FACW
Clethra alnifolia	CLAL3	FACW
Conyza canadensis	COCA5	FACU
Coreopsis linifolia	COLI5	FACW
Coreopsis tripteris	COTR4	FAC
Crotalaria purshii	CRPU5	UPL*
Ctenium aromaticum	CTAR	FACW
Cynoctonum sessifolium	CYSE	FACW
Cyperus retrorsus	CYRE5	FACU
Cyrilla racemiflora	CYRA	FACW
Dichanthelium aciculare	DIAC	FACU
Dichanthelium acuminatum	DIAC2	FAC
Dichanthelium dichotomum	DIDI6	FAC
Dichanthelium leucoblepharis	DILE3	FAC
Dichanthelium scabriusculum	DISC2	OBL
Dichromena latifolia	DILA2	FACW
Dicranium acuminatum	DICRA	OBL#[e]
Digitaria ciliaris	DICI	UPL*
Digitaria ischaemum	DIIS	UPL*
Diodia teres	DITE2	FACU
Diodia virginiana	DIVI3	FACW
Drosera capillaris	DRCA2	OBL
Drosera filiformis	DRFI	OBL
Eragrostis refracta	ERRE	FACW

SCIENTIFIC NAME[a]	CODE[b]	INDEX[c]
Eriocaulon compressum	ERCO7	OBL
Eriocaulon decangulare	ERDE5	OBL
Erigeron vernus	ERVE	OBL
Eryngium integrifolium	ERIN6	FACW
Eryngium yuccifolium	ERYU	FAC
Eupatorium sp.	EUPAT	FAC
Eupatorium anomalum	EUAN4	FAC*
Eupatorium capillifolium	EUCA5	FACU
Eupatorium compositifolium	EUCO7	FAC*
Eupatorium leucolepsis	EULE	FACW
Eupatorium rotundifolium	EURO4	FAC
Eupatorium semiserratum	EUSE	FACW
Euphorbia corollata	EUCO10	UPL*
Euthamia minor	EUMI6	FAC
Fimbristylis tomentosa	FITO	FACW
Fuirena breviseta	FUBR	OBL
Gamochaeta purpurea	GAPU3	UPL*
Gaylussacia mosieri	GAMO3	FACW*
Helianthus heterophyllus	HEHE4	OBL
Heterotheca graminifolia	HEGR10	UPL
Hypericum brachyphyllum	HYBR3	FACW
Hypericum cistifolium	HYCI	FACW
Hypericum gentianoides	HYGE	FACU
Hypoxis rigida	HYRI2	FACW
Ilex coriacea	ILCO	FACW
Ilex glabra	ILGL	FACW
Ilex myrtifolia	ILMY	FACW*
Juncus sp.	JUNCU	FACW
Juncus dichotomus	JUDI	FACW
Juncus marginatus	JUMA4	FACW
Lachnanthes caroliniana	LACA5	OBL
Lachnocaulon anceps	LAAN	OBL
Liatris spicata	LISP	FACU
Linum sp.	LINUM	FAC
Linum medium	LIME2	FAC*
Lobelia brevifolia	LOBR3	FAC
Lobelia floridana	LOFL3	OBL
Lophiola americana	LOAM3	OBL
Ludwigia linifolia	LULI	OBL
Ludwigia virgata	LUVI2	OBL
Lycopodium alopecuroides	LYAL2	OBL
Lycopodium carolinianum	LYCA3	OBL
Lycopus virginicus	LYVI	OBL
Lyonia lucida	LYLU3	FACW
Magnolia grandiflora	MAGR4	FAC
Magnolia virginiana	MAVI2	FACW
Muhlenbergia expansa	MUEX	FACW
Myrica sp.	MYRIC	FAC
Myrica cerifera	MYCE	FAC

SCIENTIFIC NAME[a]	CODE[b]	INDEX[c]
Myrica heterophyllum	MYHE	FACW
Nyssa sylvatica var. biflora	NYSY	FAC
Oldenlandia uniflora	OLUN	FACW
Oxypolis filiformis	OXFI	FACW
Pallavicinia lyellii	PALLA	OBL#
Panicum longifolium	PALO	OBL
Panicum verrucosum	PAVE2	FACW
Panicum virgatum	PAVI2	FACW
Pinus elliottii	PIEL	FACW
Pinus palustris	PIPA2	FACU
Platanthera integra	PLIN5	OBL
Pluchea foetida	PLFO	OBL
Polygala cruciata	POCR	OBL
Polygala cymosa	POCY	OBL
Polygala lutea	POLU	FACW
Polypremum procumbens	POPR4	FACU*
Quercus nigra	QUNI	FAC
Rhexia alifanus	RHAL4	FACW
Rhexia lutea	RHLU	FACW
Rhexia petiolata	RHPE	FACW
Rhynchospora sp.	RHYNC	FACW
Rhynchospora baldwinii	RHBA	OBL
Rhynchospora cephalantha	RHCE	OBL
Rhynchospora chapmanii	RHCH3	OBL
Rhynchospora corniculata	RHCO2	OBL
Rhynchospora fascicularis	RHFA	FACW
Rhynchospora filifolia	RHFI	FACW
Rhynchospora gracilenta	RHGR	OBL
Rhynchospora oligantha	RHOL	OBL
Rhynchospora pallida	RHPA	OBL
Rhynchospora plumosa	RHPL3	FACW
Rhynchospora pusilla	RHPU3	FACW
Rhynchospora rariflora	RHRA2	OBL
Rubus flagellaris	RUFL	UPL*
Rubus hispidus	RUHI	FACW*
Sabatia campanulata	SACA26	FACW
Sarracenia alata	SAAL4	OBL
Sarracenia psittacina	SAPS2	OBL
Schizachyrium scoparium	SCSC	FACU
Scleria sp.	SCLER	FACW
Scleria baldwinii	SCBA2	FACW
Scleria reticularis	SCRE	OBL
Smilax bona-nox	SMBO2	FAC
Smilax laurifolia	SMLA	FACW
Sphagnum sp.	SPHAG	OBL#
Taxodium distichum	TADI2	OBL
Tofieldia racemosa	TORA	OBL
Tragia smallii	TRSM	UPL*
Utricularia juncea	UTJU	OBL

SCIENTIFIC NAME[a]	CODE[b]	INDEX[c]
Viola lanceolata	VILA4	OBL
Woodwardia areolata	WOAR	OBL
Xyris ambigua	XYAM	OBL
Xyris baldwiniana	XYBA	OBL
Ziganenus glaberrimus	ZIGL	FACW

[a]Scientific names for species follow nomenclature of the National Wetland Plant List (Reed 1986) and Godfrey and Wooten (1979,1981).

[b]Codes are 4-6 characters assigned to species in the National Wetland Plant List (Reed 1986).

[c]Indices for species are as follows: OBL=obligate species, FACW=facultative wetland species, FAC=facultative species, FACU=facultative upland species, and UPL=upland species; indices were assigned to species in the National Wetland Plant List except where noted otherwise (see Table 2 for criteria of ecological indices).

[d]Asterisks (*) indicate that the index was assigned to the species following consultations with the National Ecology Research Center.

[e]Pound signs (#) indicate that the index was assigned to the species following consultations with Mississippi State University botanists.

APPENDIX C

FREQUENCIES OF OCCURRENCE OF SPECIES BY SOIL SERIES WITHIN VEGETATION STRATA

GROUND COVER STRATUM: ATMORE SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
RHCH3	311	10.3	311	10.3
SCRE	311	10.3	622	20.6
CTAR	300	9.9	922	30.5
DIAC2	215	7.1	1137	37.6
RHOL	121	4.0	1258	41.6
HEHE4	114	3.8	1372	45.3
ANRU	99	3.3	1471	48.6
ERCO7	90	3.0	1561	51.6
DIDI6	86	2.8	1647	54.4
SAAL4	86	2.8	1733	57.3
XYAM	85	2.8	1818	60.1
ILGL	82	2.7	1900	62.8
LACA5	81	2.7	1981	65.5
CAPS5	65	2.1	2046	67.6
DRCA2	59	1.9	2105	69.6
BAUN	58	1.9	2163	71.5
LOAM3	52	1.7	2215	73.2
BINU	48	1.6	2263	74.8
ALLU	47	1.6	2310	76.3
ERDE5	47	1.6	2357	77.9
LYAL2	47	1.6	2404	79.4
MUEX	47	1.6	2451	81.0
SMLA	41	1.4	2492	82.4
SCSC	40	1.3	2532	83.7
RHAL4	38	1.3	2570	84.9
SAPS2	38	1.3	2608	86.2
SPHAG	38	1.3	2646	87.4
CEAS	26	0.9	2672	88.3
COLI5	26	0.9	2698	89.2
ARAF	24	0.8	2722	90.0
LYCA3	23	0.8	2745	90.7
XYBA	22	0.7	2767	91.4
JUNCU	21	0.7	2788	92.1
RHGR	20	0.7	2808	92.8
RHLU	20	0.7	2828	93.5
RHPL3	18	0.6	2846	94.1
ASST2	16	0.5	2862	94.6
DILA2	16	0.5	2878	95.1
BAVI3	15	0.5	2893	95.6
LOBR3	12	0.4	2905	96.0
BUCA3	11	0.4	2916	96.4
CHTO	11	0.4	2927	96.7
HYBR3	10	0.3	2937	97.1

(Continued)

GROUND COVER STRATUM: ATMORE SERIES
(Concluded)

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
RHYNC	10	0.3	2947	97.4
UTJU	10	0.3	2957	97.7
PALO	7	0.2	2964	98.0
AGAP3	5	0.2	2969	98.1
LISP	5	0.2	2974	98.3
SCBA2	5	0.2	2979	98.4
ZIGL	5	0.2	2984	98.6
FUBR	4	0.1	2988	98.7
MYHE	4	0.1	2992	98.9
RHPE	4	0.1	2996	99.0
TORA	4	0.1	3000	99.1
DICRA	3	0.1	3003	99.2
EULE	3	0.1	3006	99.3
POLU	3	0.1	3009	99.4
ERIN6	2	0.1	3011	99.5
ERRE	2	0.1	3013	99.6
LAAN	2	0.1	3015	99.6
LIME2	2	0.1	3017	99.7
AGOB	1	0.0	3018	99.7
EUMI6	1	0.0	3019	99.8
FITO	1	0.0	3020	99.8
HYRI2	1	0.0	3021	99.8
MYCE	1	0.0	3022	99.9
PIEL	1	0.0	3023	99.9
RHFA	1	0.0	3024	99.9
SACA26	1	0.0	3025	100.0
SCLER	1	0.0	3026	100.0

GROUND COVER STRATUM: CROATAN SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
SPHAG	253	25.9	253	25.9
ERDE5	131	13.4	384	39.3
RHCO2	108	11.1	492	50.4
RHYNC	94	9.6	586	60.0
CAGL5	70	7.2	656	67.1
XYAM	41	4.2	697	71.3

(Continued)

GROUND COVER STRATUM: CROATAN SERIES
(Concluded)

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
RHCE	32	3.3	729	74.6
DISC2	28	2.9	757	77.5
PAVI2	27	2.8	784	80.2
SCSC	27	2.8	811	83.0
SMLA	22	2.3	833	85.3
POCY	19	1.9	852	87.2
ACRU	13	1.3	865	88.5
PALO	10	1.0	875	89.6
BICA	8	0.8	883	90.4
ERCO7	8	0.8	891	91.2
GAMO3	8	0.8	899	92.0
LACA5	8	0.8	907	92.8
COTR4	7	0.7	914	93.6
CYRA	7	0.7	921	94.3
RHCH3	6	0.6	927	94.9
RHGR	6	0.6	933	95.5
DRCA2	5	0.5	938	96.0
ILGL	5	0.5	943	96.5
TADI2	5	0.5	948	97.0
LOFL3	4	0.4	952	97.4
NYSY	4	0.4	956	97.9
XYBA	4	0.4	960	98.3
ANRU	2	0.2	962	98.5
ASST2	2	0.2	964	98.7
DICRA	2	0.2	966	98.9
HYBR3	2	0.2	968	99.1
LYVI	2	0.2	970	99.3
PAVE2	2	0.2	972	99.5
ERVE	1	0.1	973	99.6
JUDI	1	0.1	974	99.7
OXFI	1	0.1	975	99.8
QUNI	1	0.1	976	99.9
SCLER	1	0.1	977	100.0

GROUND COVER STRATUM: HYDE SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
ARST5	363	13.9	363	13.9
DIAC2	180	6.9	543	20.8
SCRE	149	5.7	692	26.5
RHCH3	141	5.4	833	31.9
ILGL	134	5.1	967	37.0
DISC2	119	4.6	1086	41.5
CTAR	98	3.7	1184	45.3
HEHE4	86	3.3	1270	48.6
DIDI6	76	2.9	1346	51.5
SCSC	75	2.9	1421	54.4
SPHAG	72	2.8	1493	57.1
RHPL3	63	2.4	1556	59.5
CAPS5	61	2.3	1617	61.9
MUEX	52	2.0	1669	63.8
RHYNC	52	2.0	1721	65.8
ERDE5	46	1.8	1767	67.6
BAUN	44	1.7	1811	69.3
PAVI2	43	1.6	1854	70.9
RHOL	40	1.5	1894	72.5
XYAM	40	1.5	1934	74.0
ERVE	38	1.5	1972	75.4
RHAL4	37	1.4	2009	76.9
ARAF	36	1.4	2045	78.2
ASST2	33	1.3	2078	79.5
ERCO7	31	1.2	2109	80.7
ANRU	29	1.1	2138	81.8
EULE	29	1.1	2167	82.9
COLI5	28	1.1	2195	84.0
SAAL4	25	1.0	2220	84.9
ARGI	23	0.9	2243	85.8
ASDU	20	0.8	2263	86.6
HYBR3	20	0.8	2283	87.3
DRCA2	19	0.7	2302	88.1
SCBA2	18	0.7	2320	88.8
JUNCU	16	0.6	2336	89.4
LACA5	16	0.6	2352	90.0
LOBR3	16	0.6	2368	90.6
PALLA	14	0.5	2382	91.1
PAVE2	14	0.5	2396	91.7
CEAS	13	0.5	2409	92.2
RHGR	12	0.5	2421	92.6
CHTO	11	0.4	2432	93.0
MYHE	11	0.4	2443	93.5

(Continued)

GROUND COVER STRATUM: HYDE SERIES
(Continued)

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
COTR4	9	0.3	2452	93.8
ALLU	8	0.3	2460	94.1
BINU	8	0.3	2468	94.4
LOFL3	8	0.3	2476	94.7
MYCE	8	0.3	2484	95.0
SCLER	8	0.3	2492	95.3
SMLA	8	0.3	2500	95.6
ANMO3	7	0.3	2507	95.9
EUMI6	6	0.2	2513	96.1
GAMO3	6	0.2	2519	96.4
LISP	6	0.2	2525	96.6
LOAM3	6	0.2	2531	96.8
LYAL2	6	0.2	2537	97.1
PALO	6	0.2	2543	97.3
ACRU	5	0.2	2548	97.5
BAVI3	5	0.2	2553	97.7
LULI	5	0.2	2558	97.9
EUSE	4	0.2	2562	98.0
SACA26	4	0.2	2566	98.2
UTJU	4	0.2	2570	98.3
AGAP3	3	0.1	2573	98.4
DILE3	3	0.1	2576	98.5
ILCO	3	0.1	2579	98.7
RHLU	3	0.1	2582	98.8
XYBA	3	0.1	2585	98.9
CLAL3	2	0.1	2587	99.0
DIVI3	2	0.1	2589	99.0
ERIN6	2	0.1	2591	99.1
ILMY	2	0.1	2593	99.2
POLU	2	0.1	2595	99.3
RHBA	2	0.1	2597	99.3
ASCLE	1	0.0	2598	99.4
ASLO	1	0.0	2599	99.4
AXAF	1	0.0	2600	99.5
CYSE	1	0.0	2601	99.5
DILA2	1	0.0	2602	99.5
ERRE	1	0.0	2603	99.6
FUBR	1	0.0	2604	99.6
HYCI	1	0.0	2605	99.7
LAAN	1	0.0	2606	99.7
LIME2	1	0.0	2607	99.7
MAVI2	1	0.0	2608	99.8

(Continued)

GROUND COVER STRATUM: HYDE SERIES
(Concluded)

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
OXFI	1	0.0	2609	99.8
PIEL	1	0.0	2610	99.8
PLIN5	1	0.0	2611	99.9
POCR	1	0.0	2612	99.9
RHPE	1	0.0	2613	100.0
VILA4	1	0.0	2614	100.0

GROUND COVER STRATUM: PLUMMER SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
RHCH3	411	13.6	411	13.6
CTAR	306	10.2	717	23.8
ARST5	236	7.8	953	31.6
DIAC2	166	5.5	1119	37.1
SAAL4	131	4.3	1250	41.5
HYBR3	112	3.7	1362	45.2
ILGL	107	3.6	1469	48.8
HEHE4	99	3.3	1568	52.0
ERCO7	85	2.8	1653	54.9
SCRE	75	2.5	1728	57.4
ANRU	69	2.3	1797	59.6
MUEX	68	2.3	1865	61.9
LACA5	67	2.2	1932	64.1
XYAM	66	2.2	1998	66.3
SCSC	62	2.1	2060	68.4
LOAM3	57	1.9	2117	70.3
DIDI6	56	1.9	2173	72.1
BAUN	55	1.8	2228	73.9
LYAL2	54	1.8	2282	75.7
RHAL4	53	1.8	2335	77.5
RHLU	53	1.8	2388	79.3
CAPS5	50	1.7	2438	80.9
ERDE5	47	1.6	2485	82.5
SMLA	41	1.4	2526	83.8
GAMO3	35	1.2	2561	85.0
COLI5	32	1.1	2593	86.1
DRCA2	32	1.1	2625	87.1

(Continued)

GROUND COVER STRATUM: PLUMMER SERIES
(Concluded)

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
LAAN	28	0.9	2653	88.1
SPHAG	27	0.9	2680	88.9
LYCA3	26	0.9	2706	89.8
ALLU	24	0.8	2730	90.6
ARAF	23	0.8	2753	91.4
XYBA	23	0.8	2776	92.1
BINU	21	0.7	2797	92.8
ILCO	21	0.7	2818	93.5
RHPL3	20	0.7	2838	94.2
LOBR3	19	0.6	2857	94.8
CHTO	14	0.5	2871	95.3
ASST2	13	0.4	2884	95.7
PIEL	13	0.4	2897	96.2
BAVI3	11	0.4	2908	96.5
RHYNC	11	0.4	2919	96.9
SAPS2	10	0.3	2929	97.2
PAVI2	9	0.3	2938	97.5
ERRE	8	0.3	2946	97.8
POLU	8	0.3	2954	98.0
DILE3	6	0.2	2960	98.2
RHGR	6	0.2	2966	98.4
CEAS	5	0.2	2971	98.6
DICRA	5	0.2	2976	98.8
RHOL	5	0.2	2981	98.9
MYCE	4	0.1	2985	99.1
ANMO3	3	0.1	2988	99.2
FUBR	3	0.1	2991	99.3
JUNCU	3	0.1	2994	99.4
BUCA3	2	0.1	2996	99.4
SCBA2	2	0.1	2998	99.5
TORA	2	0.1	3000	99.6
ACRU	1	0.0	3001	99.6
AGAP3	1	0.0	3002	99.6
CYSE	1	0.0	3003	99.7
DRFI	1	0.0	3005	99.7
ERVE	1	0.0	3006	99.8
FITO	1	0.0	3007	99.8
JUMA4	1	0.0	3008	99.8
LIME2	1	0.0	3009	99.9
MYRIC	1	0.0	3010	99.9
RHFI	1	0.0	3011	99.9
RHPE	1	0.0	3012	100.0
UTJU	1	0.0	3013	100.0

GROUND COVER STRATUM: HARLESTON SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
ARST5	390	22.2	390	22.2
PAVE2	141	8.0	531	30.2
ILCO	127	7.2	658	37.5
ILGL	111	6.3	769	43.8
DIIS	95	5.4	864	49.2
LACA5	72	4.1	936	53.3
GAMO3	64	3.6	1000	56.9
SMLA	62	3.5	1062	60.4
EUMI6	51	2.9	1113	63.3
SCSC	48	2.7	1161	66.1
RHCH3	32	1.8	1193	67.9
XYAM	29	1.7	1222	69.6
CTAR	27	1.5	1249	71.1
SCRE	26	1.5	1275	72.6
RHAL4	25	1.4	1300	74.0
DIAC	24	1.4	1324	75.4
DIAC2	23	1.3	1347	76.7
HEHE4	22	1.3	1369	77.9
LAAN	20	1.1	1389	79.1
MYCE	20	1.1	1409	80.2
DIVI3	17	1.0	1426	81.2
DIDI6	16	0.9	1442	82.1
LYAL2	16	0.9	1458	83.0
DICI	15	0.9	1473	83.8
DILE3	15	0.9	1488	84.7
EUAN4	14	0.8	1502	85.5
LOAM3	14	0.8	1516	86.3
RUHI	13	0.7	1529	87.0
MUEX	12	0.7	1541	87.7
EUCA5	11	0.6	1552	88.3
COCA5	10	0.6	1562	88.9
LYCA3	10	0.6	1572	89.5
VILA4	10	0.6	1582	90.0
WOAR	10	0.6	1592	90.6
ANRU	9	0.5	1601	91.1
ERRE	9	0.5	1610	91.6
ASST2	7	0.4	1617	92.0
CYRE5	7	0.4	1624	92.4
DRCA2	7	0.4	1631	92.8
LUVI2	7	0.4	1638	93.2
BAUN	6	0.3	1644	93.6
BINU	6	0.3	1650	93.9
EURO4	6	0.3	1656	94.3

(Continued)

GROUND COVER STRATUM: HARLESTON SERIES
(Continued)

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
MAVI2	6	0.3	1662	94.6
MYHE	6	0.3	1668	94.9
OLUN	6	0.3	1674	95.3
RHPL3	6	0.3	1680	95.6
SMBO2	6	0.3	1686	96.0
EULE	5	0.3	1691	96.2
EUPAT	4	0.2	1695	96.5
POPR4	4	0.2	1699	96.7
SCLER	4	0.2	1703	96.9
FITO	3	0.2	1706	97.1
NYSY	3	0.2	1709	97.3
RHRA2	3	0.2	1712	97.4
ACRU	2	0.1	1714	97.6
ANTEN	2	0.1	1716	97.7
ASDU	2	0.1	1718	97.8
DICRA	2	0.1	1720	97.9
HYBR3	2	0.1	1722	98.0
LOBR3	2	0.1	1724	98.1
PIEL	2	0.1	1726	98.2
RHFA	2	0.1	1728	98.3
RHPE	2	0.1	1730	98.5
RHYNC	2	0.1	1732	98.6
RUFL	2	0.1	1734	98.7
AXAF	1	0.1	1735	98.7
CANI4	1	0.1	1736	98.8
CEAS	1	0.1	1737	98.9
CRPU5	1	0.1	1738	98.9
DITE2	1	0.1	1739	99.0
ERYU	1	0.1	1740	99.0
EUCO10	1	0.1	1741	99.1
EUCO7	1	0.1	1742	99.1
GAPU3	1	0.1	1743	99.2
HEGR10	1	0.1	1744	99.3
HYGE	1	0.1	1745	99.3
JUDI	1	0.1	1746	99.4
LINUM	1	0.1	1747	99.4
PLFO	1	0.1	1748	99.5
POLU	1	0.1	1749	99.5
RHFI	1	0.1	1750	99.6
RHGR	1	0.1	1751	99.7
RHLU	1	0.1	1752	99.7
RHOL	1	0.1	1753	99.8

(Continued)

GROUND COVER STRATUM: HARLESTON SERIES
(Concluded)

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
RHPA	1	0.1	1754	99.8
RHPU3	1	0.1	1755	99.9
SCBA2	1	0.1	1756	99.9
TRSM	1	0.1	1757	100.0

SMALL SHRUB STRATUM: ATMORE SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
ILGL	34	100.0	34	100.0

SMALL SHRUB STRATUM: CROATAN SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
LYLU3	6	27.3	6	27.3
CYRA	4	18.2	10	45.5
HYBR3	4	18.2	14	63.6
ACRU	3	13.6	17	77.3
ILGL	3	13.6	20	90.9
CLAL3	1	4.5	21	95.5
SMLA	1	4.5	22	100.0

SMALL SHRUB STRATUM: HYDE SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
ILGL	166	83.4	166	83.4
MYCE	14	7.0	180	90.5
ASST2	5	2.5	185	93.0
HYBR3	5	2.5	190	95.5
SMLA	5	2.5	195	98.0
ILMY	3	1.5	198	99.5
PIEL	1	0.5	199	100.0

SMALL SHRUB STRATUM: PLUMMER SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
ILGL	138	71.9	138	71.9
HYBR3	33	17.2	171	89.1
ILCO	8	4.2	179	93.2
MAVI2	4	2.1	183	95.3
SMLA	4	2.1	187	97.4
MYCE	3	1.6	190	99.0
GAMO3	1	0.5	191	99.5
PIEL	1	0.5	192	100.0

SMALL SHRUB STRATUM: HARLESTON SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
ILGL	103	55.1	103	55.1
ILCO	66	35.3	169	90.4
MAVI2	10	5.3	179	95.7
GAMO3	3	1.6	182	97.3
RUHI	2	1.1	184	98.4
ILMY	1	0.5	185	98.9
NYSY	1	0.5	186	99.5
SMLA	1	0.5	187	100.0

LARGE SHRUB STRATUM: CROATAN SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
ILCO	2	100.0	2	100.0

LARGE SHRUB STRATUM: PLUMMER SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
ILCO	6	100.0	6	100.0

LARGE SHRUB STRATUM: HARLESTON SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
ILGL	13	54.2	13	54.2
ILCO	11	45.8	24	100.0

TREE STRATUM: CROATAN SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
TADI2	11465	54.8	11465	54.8
NYSY	5583	26.7	17048	81.5
CYRA	1935	9.3	18983	90.8
PIEL	1293	6.2	20276	97.0
ACRU	332	1.6	20608	98.6
PIPA2	252	1.2	20860	99.8
MAVI2	26	0.1	20886	99.9
QUNI	11	0.1	20897	100.0
MYCE	8	0.0	20905	100.0

TREE STRATUM: HYDE SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
PIEL	1443	98.4	1443	98.4
MAGR4	24	1.6	1467	100.0

TREE STRATUM: PLUMMER SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
PIEL	767	55.4	767	55.4
PIPA2	617	44.6	1384	100.0

TREE STRATUM: HARLESTON SERIES

CODE[a]	Frequency[b]	Percent	Cumulative frequency	Cumulative percent
PIEL	2825	91.5	2825	91.5
NYSY	176	5.7	3001	97.2
ILGL	87	2.8	3088	100.0

[a]Codes for species correspond to those given in Appendix B.
[b]Frequencies are weighted by relative abundance of individual species within the vegetation strata.

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16. Abstract (Limit: 200 words)

As part of a national study, vegetation associated with known hydric soil series was sampled on the Mississippi Sandhill Crane National Wildlife Refuge in southern Mississippi. Weighted average values were calculated for vegetation associations on each soil series sampled using the technique developed for the Fish and Wildlife Service by Dr. T.R. Wentworth and G.P. Johnson, North Carolina State University. Good correlations were observed between soils on the Soil Conservation Service's hydric soils list and hydrophytic vegetation identified in the National Wetland Plant List (1986) developed by the Fish and Wildlife Service. However, one soil not on the list supported hydrophic vegetation.

17. Document Analysis a. Descriptors

Wetland soils
Wetland plants
Hydric soils
Hydrophytic vegetation

b. Identifiers/Open-Ended Terms

Mississippi wetlands
Coastal plain wetlands
Palustrine wetlands

c. COSATI Field/Group

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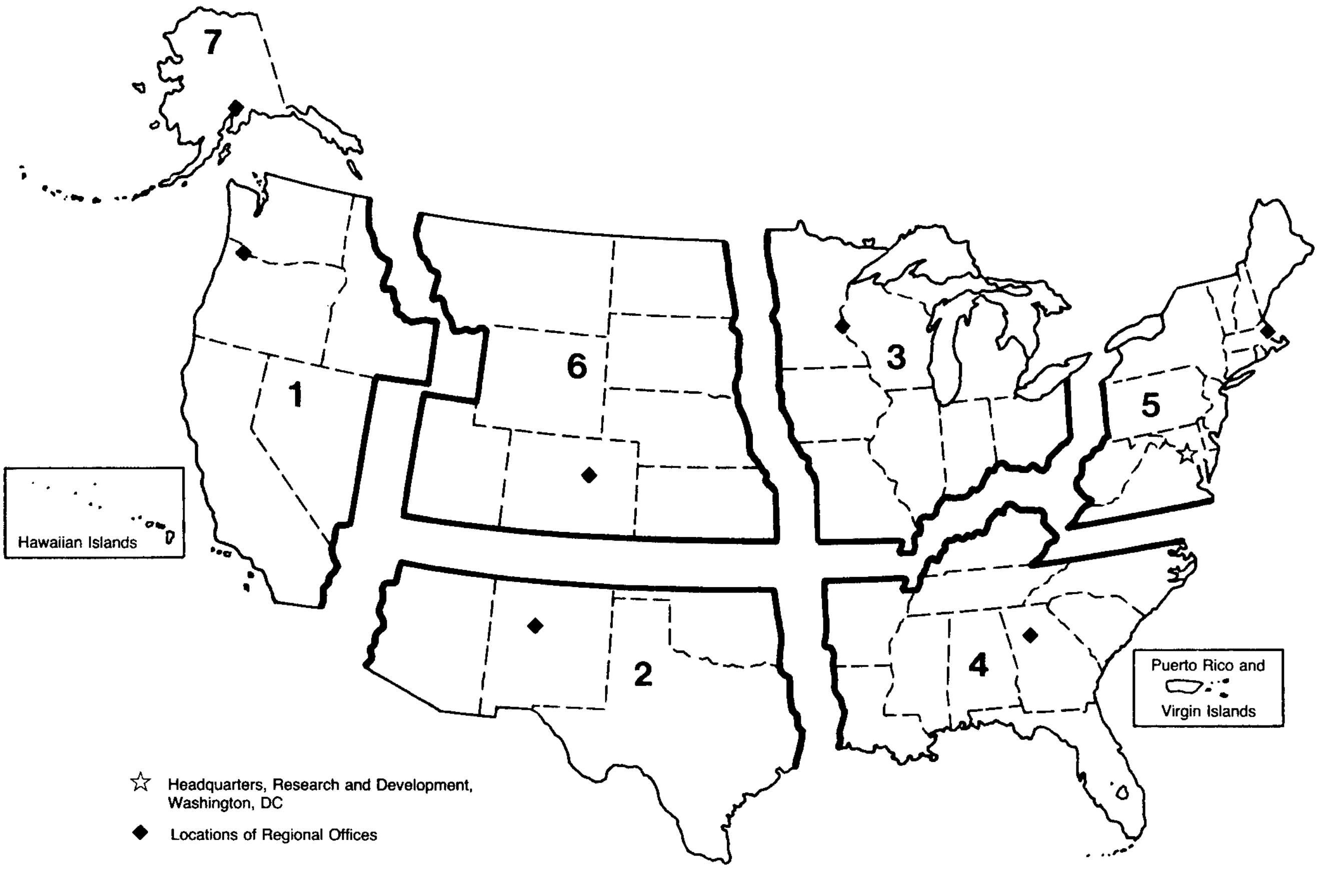

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